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(71)Applicant : **NIPPON STEEL CORP**
(72)Inventor : **OGAMI MASAHIRO**
MANGAYA TETSUYA
TAKASUGI NAOKI
ICHIYAMA TAKAHIRO
TAKEDA OSAMU

(54) ELECTRIC RESISTANCE WELDED STEEL TUBE FOR HOLLOW STABILIZER

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an electric resistance welded steel tube for a hollow stabilizer, which is manufactured at a low cost and whose problems on hardenability and the like are solved.
SOLUTION: The tube consists, by mass%, of 0.2-0.35% C, 0.1-0.5% Si, 0.3-1.5% Mn, 0.01-0.1% Al, 0.001-0.04% Ti, 0.0005-0.005% B, 0.001-0.01% N, ≤ 0.03%P, ≤ 0.02% S, ≤ 0.015% O, and the balance Fe with inevitable impurities. Besides, the tube satisfies (N-0.002)/14.01<Ti/47.88 and (Ti-0.02)/47.88<N/14.01.

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[Claim 1]
By mass %, C:0.2 to 0.35%, Si:0.1-0.5%, Mn:0.3-1.5%, aluminum:0.01-0.1%, Ti:0.001-0.04%, B:0.0005 to 0.005%, N:0.001 to 0.01%, A high frequency welded steel tube for hollow stabilizers the remainder's consisting of Fe and an inescapable impurity, and satisfying following the (1) type and (2) types P:0.03% or less, S:0.02% or less, and O:0.015% or less.
(N-0.002) /14.01<Ti/47.88 .. (1) type
(Ti-0.02) /47.88<N/14.01 .. (2) types

[Claim 2]
The high frequency welded steel tube for hollow stabilizers according to claim 1

characterized by containing nickel:0.005-1%, Cr:0.05-1%, and Mo:0.005-1% of one sort, or two sorts or more by mass %.

[Claim 3]
The high frequency welded steel tube for hollow stabilizers according to claim 1 or 2 performing diameter reduction rolling.

[Claim 4]
t/D which is a ratio of steel pipe thickness (t) to a steel pipe outer diameter (D) -- 0.15 super-****** -- the high frequency welded steel tube for hollow stabilizers according to any one of claims 1 to 3 characterized by things.

[Claim 5]
The high frequency welded steel tube for hollow stabilizers according to any one of claims 1 to 4 performing tube straightening.

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[Detailed Description of the Invention]
[0001]
[Field of the Invention]
This invention relates to the high frequency welded steel tube for hollow stabilizers excellent in especially hardenability about the hollow stabilizer which secures the running stability of a car.
[0002]
[Description of the Prior Art]
The weight saving of the body is advanced as one of the measures against fuel consumption improvement of a car, rolling of the body is eased at the time of a cornering, and the stabilizer which secures the running stability of the body at the time of high speed operation is also contained in it. In manufacture of a stabilizer, hardenability reservation is required in heat treatment carried out in order to obtain high fatigue strength.
[0003]
Although the conventional stabilizer is the inner substance material which processed bar steel into the product configuration, in order to attain a weight saving, the steel pipe which are hollow material, such as seamless steel tubes and a high frequency welded steel tube, is being used more often.
Especially heavy-gage hollow material is required increasingly.

[0004]
As a hollow stabilizer element tube as which the characteristics, such as hardenability, are required, there is application of a structural steel worker alloy steel steel pipe or a machine structural-carbon-steel steel pipe. However, a structural steel worker alloy steel steel pipe is high-cost, and the steel-for-machine-structural-use steel pipe has a problem in hardening.

[0005]
The chemical entity of the high frequency welded steel tube for hollow stabilizers is indicated to JP,H1-58264,B and JP,S61-45688,B. Here, regulation of Ti at the time of B addition which is an element important for the improvement in hardenability is regulated in the sum total of N and O. Each restriction cannot be found about N and O. Furthermore also in which gazette, there is no description about the heavy-gage hollow-drill-steel pipe with which t/D which is a ratio of steel pipe thickness (t) to a steel pipe outer diameter (D) exceeds 0.15.
[0006]
[Problem to be solved by the invention]
In the chemical entity of the high frequency welded steel tube for hollow stabilizers indicated to above-mentioned JP,H1-58264,B and JP,S61-45688,B. Regulation of Ti at the time of B addition which is an element important for the improvement in hardenability is regulated in the sum total of N and O, and is insufficient for securing hardenability in heat treatment. About N and O, since each restriction cannot be found, control of toughness and an oxide is insufficient.
[0007]
In the hollow stabilizer, in spite of having required heavy-gage hollow material increasingly, manufacture of the heavy-gage hollow material in which t/D exceeds 0.15 in a high frequency welded steel tube was difficult.
[0008]
An object of this invention is to provide the new high frequency welded steel tube which has the characteristic for which it was suitable as a stabilizer that many problems of such hollow stabilizer manufacture should be solved.
[0009]
[Means for solving problem]
That is, the place made into the summary of this invention is as follows.
By mass %, (1) C:0.2 to 0.35%, Si:0.1-0.5%, Mn:0.3-1.5%, aluminum:0.01-0.1%, Ti:0.001-0.04%, B:0.0005 to 0.005%, N:0.001 to 0.01%, The remainder consists of Fe and an inescapable impurity P:0.03% or less, S:0.02% or less, and O:0.015% or less, and it is following the (1) type. And high frequency welded steel tube for hollow stabilizers satisfying (2) types.
(N-0.002) /14.01<Ti/47.88 .. (1) type
(Ti-0.02) /47.88<N/14.01 .. (2) types
(1) In a formula and (2) types, Ti and N express mass % of titanium and a nitrogen content, respectively.
(2) A high frequency welded steel tube for hollow stabilizers given in the above (1) characterized by containing nickel:0.005-1%, Cr:0.05-1%, and Mo:0.005-1% of one sort, or two sorts or more by mass %.
(3) The above (1) performing diameter reduction rolling or a high frequency welded steel tube for hollow stabilizers given in (2).
(4) t/D which is a ratio of steel pipe thickness (t) to a steel pipe outer diameter (D) -- 0.15 super-****** -- a high frequency welded steel tube for hollow stabilizers given in any of (3) they are from the above (1) characterized by things.
(5) A high frequency welded steel tube for hollow stabilizers given in any of (4) they are from the above (1) performing tube straightening.

[0010]
[Mode for carrying out the invention]
Although a hot-rolled raw material which has specific chemical composition is used in this invention, a means in particular to manufacture the hot-rolled raw material is not limited. A method of carrying out diameter reduction rolling of the steel pipe manufactured as a manufacturing method of a high frequency welded steel tube by an electric resistance welding technique and an electric resistance welding technique using high frequency current with a diameter reduction rolling mill and how a cold drawing machine performs tube straightening in order to prepare form of a steel pipe further after carrying out diameter reduction rolling can be ******(ed).
[0011]
Next, the chemical entity of a steel pipe is explained.
C deposits as dissolution or carbide all over a base, it is an element to which the intensity of steel is made to increase, and deposits as the 2nd phase with hard cementite, perlite, bainite, martensite, etc., and contributes to improvement in high-intensity-izing and uniform elongation. Although 0.2% or more of C was required because of improving strength, since processability and weldability would deteriorate if C content exceeds 0.35%, C was specified in 0.2 to 0.35% of range.
[0012]
Si is a solid-solution-strengthening type alloy element, in order to secure intensity, 0.1% of Si is required for it, but if it exceeds 0.5%, it will become easy to generate the inclusion of a Si-Mn system which serves as a weld flaw at the time of electric resistance welding, and will have an adverse effect on the soundness of an electric-resistance-welding part. For this reason, Si was specified in 0.1 to 0.5% of range. It is 0.1 to 0.3% preferably.
[0013]
In order that Mn might have an adverse effect also on weldability and the soundness of a weld zone as being an element which raises intensity and hardenability, and fully being unable to obtain intensity at the time of hardening at less than 0.3%, and exceeding 1.5%, Mn was specified in 0.3 to 1.5% of range.
[0014]
aluminum is a required element used as deoxidation material of molten steel, and it is also an element which fixes N, and the quantity has big influence on a crystal grain diameter or mechanical properties. In order to have such an effect, 0.01% or more of content is required, but if it exceeds 0.1%, nonmetallic inclusion will increase and it will become easy to generate a surface flaw for a product. For this reason, aluminum was specified in 0.01 to 0.1% of range.
[0015]
although it acts in order that Ti may raise hardenability by B addition stably and effectively -- less than [Ti:0.001%] -- and
(N-0.002) /14.01<Ti/47.88 (1) type
In the range which is not satisfied, an effect cannot be expected but it reaches more than Ti:0.04%.
(Ti-0.02) /47.88<N/14.01 (2) types
In the range which is not satisfied, many nitrides of Ti generate to an electric-resistance-welding abutting part, and there is a tendency for toughness to deteriorate. Therefore,

while specifying Ti in 0.001 to 0.04% of range, the above-mentioned (1) formula and (2) types were specified.

[0016]

A little B is elements which raise the hardenability of steel materials substantially by addition, and has an effect of precipitation strengthening as crystal stressing, $M_{23}(C, B)_6$, etc. If an addition cannot expect an effect from hardenability at less than 0.0005% and exceeds 0.005%, there will be a tendency which generates big and rough B containing phase, and embrittlement will take place easily. For this reason, B was specified in 0.0005 to 0.005% of range.

[0017]

N is one of the important elements which deposit a nitride or carbon nitride and raise intensity. Although an effect is demonstrated by 0.001% or more of addition, if it exceeds 0.01%, a tendency for toughness to deteriorate will be seen by big-and-rough-izing of a nitride, and age-hardening by the dissolution N. For this reason, N was specified in 0.001 to 0.01% of range.

[0018]

Since P was an element which has an adverse effect on weld-cracking nature and toughness, P was regulated to 0.03% or less. It is 0.02% or less preferably.

[0019]

S influences nonmetallic inclusion in steel, and it causes increase of toughness degradation, anisotropy, and stress-relief cracking susceptibility while degrading the bendability of a steel pipe, and flat nature. In order to also affect the soundness of a weld zone, S was specified to 0.02% or less. It is 0.01% or less preferably.

[0020]

While O causes generation of an oxide which has an adverse effect on toughness, in order to generate an oxide used as a starting point of fatigue breaking and to degrade fatigue durability, a maximum was specified to 0.015%.

[0021]

nickel is an element which raises hardenability and toughness. At less than 0.005%, if an effect cannot be expected but it exceeds 1%, in order for the remains gamma to generate at the time of hardening and to degrade fatigue durability, nickel was specified in 0.005 to 1% of range. When nickel content range is made into 0.015 to 0.5%, it is more preferred.

[0022]

It has the operation which miniaturizes carbide while Cr is an element which raises hardenability, and has the effect of depositing $M_{23}C_6$ type carbide into a matrix and raises intensity. at less than 0.05%, since it would become easy to generate penetrator at the time of welding if these effects cannot expect enough and exceed 1%, Cr was specified in 0.05 to 1% of range.

[0023]

Mo is an element which stabilizes $M_{23}C_6$ while it is an element which raises hardenability and is an element which brings about solid solution strengthening. At less than 0.005%, if this effect cannot expect enough but exceeds 1%, in order to be easy to deposit big and rough carbide and to degrade toughness, Mo was specified in 0.005 to 1% of range.

[0024]

Next, the Reason which limited t/D which is a ratio of steel pipe thickness (t) to a steel

pipe outer diameter (D) to 0.15 ** is explained. Although thickness/outside clearance ratio (t/D) can generally manufacture 0.15 or less high frequency welded steel tube, if t/D exceeds 0.15, it will become more than the capability of a high frequency welded steel tube tubulation machine, and manufacture becomes difficult. carrying out diameter reduction rolling of the high frequency welded steel tube with the reducing mill between heat in this invention -- t/D;0.15 ** which was difficult for manufacture in the former and a high frequency welded steel tube -- manufacture -- since it was easy, the object of t/D was 0.15 super-**(ed).

[0025]

It is desirable when tube straightening of the high frequency welded steel tube is carried out eventually. By carrying out tube straightening, improvement in the dimensional accuracy of a steel pipe is aimed at, and it is because surface quality can be improved.

[0026]

Hardening hardness can be set to 420 or more Hv(s) by performing hardening heat treatment to the high frequency welded steel tube of this invention, and making the rate of martensite into not less than 90%.

[0027]

[Working example]

Various steel with a presentation of Table 1 was cast in slab. These slab was heated at 1150 **, and it was considered as finishing temperature of 900 ** with hot-rolling, and was considered as hot rolled sheet steel of 6.5 mm of board thickness with coiling temperature of 670 **. After carrying out the slit of the hot rolled sheet steel to predetermined width, it was considered as a with an outer diameter [6.5-mm thickness of 89.1 mm] high frequency welded steel tube by high frequency welding. After heating to an austenite region beyond Ac_3 point by high-frequency induction heating about some steel pipes among two or more high frequency welded steel tubes, a reducing mill between heat performed diameter reduction rolling, it was considered as a with an outer diameter [7-mm thickness of 36.8-63.5 mm] steel pipe, and tube straightening was performed about some steel pipes. In order to investigate hardening hardness of each steel pipe, this steel pipe is heated at 950 **, and it is ******** to underwater. About hardening ******, the determination of hardness was carried out for a section vertical to a tube axial direction with the Vickers hardness scale, and also a metal texture was observed with an optical microscope, and a rate of martensite was measured. A manufacture result is shown in Table 2.

[0028]

[Table 1]

No.	化学成分 (mass%)													式①		式②		備考
	C	Si	Mn	P	S	Al	Cr	Mo	B	Ti	Ni	N	O	式(N−0.002)/14.01 ＜Ti/47.88		式(Ti−0.02)/47.88 ＜N/14.01		
														(N−0.002) /14.01	Ti/47.88	(Ti−0.02) /47.88	N/14.01	
A	0.24	0.35	0.67	0.020	0.012	0.038	0.03	0.002	0.0012	0.052	0.210	0.0024	0.0018	0.0000	0.0011	** 0.0007	0.0002	比較例
B	0.23	0.21	0.52	0.015	0.005	0.024	0.02	0.002	0.0015	0.012	0.015	0.0038	0.0020	0.0001	0.0003	−0.0002	0.0003	本発明
C	0.20	0.75	1.24	0.025	0.011	0.018	0.01	0.003	0.0021	0.005	0.257	0.0085	0.0038	** 0.0005	0.0001	−0.0003	0.0006	比較例
D	0.25	0.26	0.52	0.014	0.005	0.021	0.03	0.003	0.0016	0.013	0.022	0.0041	0.0032	0.0001	0.0003	−0.0001	0.0003	本発明
E	0.23	0.22	0.57	0.012	0.003	0.024	0.03	0.001	0.0021	0.012	0.013	0.0021	0.0019	0.0000	0.0003	−0.0002	0.0001	本発明
F	0.23	0.21	0.33	0.012	0.005	0.023	0.02	0.002	0.0017	0.015	0.024	0.0028	0.0032	0.0001	0.0003	−0.0001	0.0002	本発明
G	0.23	0.58	0.57	0.010	0.005	0.022	0.03	0.002	0.0015	0.014	0.145	0.0041	0.0031	0.0001	0.0003	−0.0001	0.0003	本発明
H	0.25	0.23	0.56	0.008	0.008	0.030	0.35	0.003	0.0015	0.013	0.014	0.0035	0.0042	0.0001	0.0003	−0.0001	0.0002	本発明
I	0.23	0.19	0.49	0.011	0.012	0.028	0.35	0.23	0.0022	0.014	0.021	0.0033	0.0028	0.0001	0.0003	−0.0001	0.0002	本発明
J	0.23	0.22	0.31	0.011	0.008	0.018	0.02	0.003	0.0018	* 0.0005	0.017	0.0054	0.0076	** 0.0002	0.0000	−0.0004	0.0004	比較例
K	0.23	0.23	0.33	0.011	0.006	0.027	0.02	0.003	0.0033	* 0.105	0.321	0.0032	0.0085	0.0001	0.0022	** 0.0018	0.0002	比較例
L	* 0.08	0.27	0.54	0.015	0.014	* 0.007	0.02	0.002	0.0022	0.011	0.054	0.0035	0.0064	0.0001	0.0002	−0.0002	0.0002	比較例
M	* 0.43	0.28	0.55	0.015	0.010	* 0.121	0.01	0.001	* 0.0002	0.049	0.126	0.0038	0.0055	0.0001	0.0010	** 0.0006	0.0003	比較例
N	0.24	* 0.04	0.53	0.017	0.012	0.022	0.02	0.002	* 0.0095	0.014	0.254	0.0039	0.0041	0.0001	0.0003	−0.0001	0.0003	比較例
O	0.28	* 0.85	0.61	0.016	0.009	0.025	0.01	0.003	0.0032	0.028	0.153	* 0.0196	0.0024	** 0.0013	0.0006	0.0002	0.0014	比較例
P	0.22	0.65	* 0.15	0.011	0.009	0.031	0.02	0.003	0.0012	0.023	0.182	0.0055	0.0038	0.0002	0.0005	0.0001	0.0004	比較例
Q	0.23	0.61	* 1.65	0.012	0.010	0.027	0.01	0.003	0.0035	0.017	0.354	0.0052	0.0042	0.0002	0.0004	−0.0001	0.0004	比較例
R	0.23	0.18	0.52	* 0.051	0.006	0.025	0.35	0.12	0.0011	0.015	0.215	0.0032	0.0076	0.0001	0.0003	−0.0001	0.0002	比較例
S	0.24	0.25	0.67	0.011	* 0.035	0.031	0.37	0.002	0.0018	0.015	* 1.252	0.0046	0.0054	0.0002	0.0003	−0.0001	0.0003	比較例
T	0.21	0.19	0.53	0.012	0.010	0.021	0.34	0.11	0.0012	0.016	0.037	0.0021	* 0.0182	0.0000	0.0003	−0.0001	0.0001	比較例
U	0.25	0.22	0.52	0.009	0.008	0.035	* 1.31	0.20	0.0021	0.011	0.043	0.0019	0.0072	0.0000	0.0002	−0.0002	0.0001	比較例
V	0.23	0.17	0.45	0.010	0.013	0.025	0.34	* 1.22	0.0021	0.013	0.024	0.0022	0.0080	0.0000	0.0003	−0.0001	0.0002	比較例

＊：本発明の特許請求範囲を外れているもの

＊＊：本発明の式①および式②の範囲を外れているもの

[0029]
[Table 2]

No.	焼入れ硬さ Hv (10kg)	マルテンサイト率 (%)	t/D	縮径圧延有無	伸管有無	溶接衝合部衝撃特性	加工特性		備考
							曲げ試験 90°－2D	管端圧着試験 H＝4t	
A	515	100	0.13	－	－	×	○	×	比較例
B	506	100	0.15	－	－	○	○	○	本発明
C	384	90	0.12	－	－	×	○	×	比較例
D	526	100	0.17	有	－	○	○	○	本発明
E	507	100	0.19	有	－	○	○	○	本発明
F	504	100	0.18	有	－	○	○	○	本発明
G	505	100	0.16	－	有	○	○	○	本発明
H	526	100	0.19	有	－	○	○	○	本発明
I	501	100	0.18	有	－	○	○	○	本発明
J	365	85	0.12	－	－	○	○	×	比較例
K	451	95	0.11	－	－	×	×	×	比較例
L	254	85	0.13	－	－	○	○	×	比較例
M	448	80	0.10	－	有	×	×	×	比較例
N	516	100	0.12	－	－	×	×	×	比較例
O	352	80	0.12	－	－	×	×	×	比較例
P	313	80	0.11	－	－	○	○	×	比較例
Q	501	100	0.13	－	－	×	×	×	比較例
R	506	100	0.09	－	有	×	×	×	比較例
S	516	100	0.13	－	－	×	×	×	比較例
T	487	100	0.12	－	－	×	○	×	比較例
U	521	100	0.14	－	－	×	×	×	比較例
V	505	100	0.11	－	－	○	×	×	比較例

[0030]
The hardening hardness of the example of this invention (No.B, No.D, No.E, No.F, No.G, No.H, No.I) shown in Table 1 is Hv420 by making the rate of martensite into not less than 90%. It is above.
The characteristic that a welding abutting part impact property is also good, and it is required as a steel pipe for stabilizers is satisfied, and the crack has not arisen in the bending test and the edge-of-a-winding-instrument sticking-by-pressure examination.
As compared with it, hardening hardness, the welding abutting part impact property, and the working characteristic have deteriorated in the comparative example which separated from the range of this invention.

[0031]
Since the element required for hardenability has not satisfied shortage, or a formula (N-0.002) / 14.01<Ti/47.88, a comparative example (No.C, No.J, No.L, No.O, No.P) is an example with which it is not satisfied of hardening hardness. Since the comparative example (No.A, No.K, No.M) has not satisfied a formula (Ti-0.02) / 47.88<N/14.01, it is an example for which many nitrides of Ti were generated by the electric-resistance-welding abutting part, and the welding abutting part impact property deteriorated.
[0032]
Since comparative example No.N generated B containing phase big and rough since the amount of B is over default value, it embrittles, and an impact property is the example which the crack generated in degradation and an edge-of-a-winding-instrument sticking-by-pressure examination. Since the amount of Mn of comparative example No.Q is over default value, respectively, the amount of Si comparative example No.O, Since the inclusion of a Si-Mn system was generated at the time of electric resistance welding and the impact property and processability of the welding abutting part fell, an impact property is the example which the crack generated in degradation, the bending test, and the edge-of-a-winding-instrument sticking-by-pressure examination.
[0033]
As for comparative example No.S, since the amount of S is over default value, respectively, the amount of P of comparative example No.R is the example for which the welding abutting part impact property deteriorated. Since the amount of O is over default value, an oxide generates many comparative example No.T, and a welding abutting part impact property is the example which the crack generated in degradation and an edge-of-a-winding-instrument sticking-by-pressure examination. Comparative example No.U is the example which penetrator generated mostly at the time of electric resistance welding since the amount of Cr(s) was over default value, and the crack generated in degradation and the bending test of a welding abutting part impact property, and the edge-of-a-winding-instrument sticking-by-pressure examination.
[0034]
Comparative example No.V is the example which big and rough carbide generated mostly since the amount of Mo was over default value, and the crack generated in the bending test and the edge-of-a-winding-instrument sticking-by-pressure examination. Comparative example No.I is the example which toughness fell since Ti quantity was over default value, and the crack generated in the edge-of-a-winding-instrument sticking-by-pressure examination.
[0035]
[Effect of the Invention]
The high frequency welded steel tube for hollow stabilizers of this invention has high hardening hardness, and is excellent also in the impact property and processability of an electric-resistance-welding abutting part.
It is able for a 0.15 super-****** reason, to contribute to simplification of a work process, while t/D contributes to a weight saving.

[Translation done.]

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